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SCIENCE AND POPULATION TRENDS

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SCIENCE AND POPULATION TRENDS

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Technology and the Death Rate

1. The effect of science on the death rate is best approached through separate causes of death. The ambiguity of the notion of cause in vital statistics can be resolved for the present purpose by classifying deaths according to the several enemies which kill him. We take up successively bacteria, other organic beings, other natural elements, human enemies of man, and man himself.

2. Bacteria have always been man's principal enemy. History is marked by plagues and epidemics aside from these sudden flare-ups a continuous loss of life, through infection and disease, especially of children, has been taken for granted in all past ages. It was the 19th century that brought bacteria under control, starting with Jenner's invention of vaccination against smallpox, continuing through Semmelweiss's defeat of puerperal fever with chlorinated water, and Pasteur's theoretical discoveries in the 1870's. (2) Contagious diseases affecting children dropped by 87 per cent in England and Wales during the century ending in 1947, and other countries with good statistics showed similar results. What mortality remained was attacked in the 1940's with anti-biotics, and puerperal fever and tuberculosis eliminated in a fresh offensive. Canadian statistics of deaths of women in childbirth show the striking effect of anti-biotics on deaths in childbirth. In 1930-32 there was about one maternal death per 200 live births; in 1940-42 about one in 250 births; in 1959 about one in 2000 births. (3) Aside from inoculation and anti-biotics, bacteria were dealt with through urban sanitation. The individual wells by which city people secured their water were replaced by municipal systems in which filtration and the use of chlorine brought the bacterial content of drinking water down to safe proportions, a result achieved in most parts of western Europe and North America by about 1900.

3. During the pre-historic life of the human race, the contest of men with other animals was undoubtedly a substantial cause of mortality. Even during historic times in Asia and Europe

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(2) Causes et conséquences de l'évolution démographique. Nations Unies, New York, page 66 (1953).

(3) Canada Year Book, page 225 (1961).

accounts of marauding beasts are common, but the total of deaths they caused was small. Much more important were insects and rats which brought various diseases, including bubonic plague. For the most part these were dealt with by attack on the bacteria carried by the animal, but in the instance of malaria technology was used to attack the carrier. DDT was invented about 1940 and applied soon after to the mosquito, with striking results. In 1940 Ceylon had 20.6 deaths per thousand of population; in 1946 she had 20.3; in 1947 the figure dropped to 14.3; in 1948 to 13.2. So rapidly is the practice of house-spraying being extended, and so effective is it proving, that the world-wide eradication of malaria is close at hand. Next to the mortality directly brought by disease-carrying animals and insects, the competition of rats and other animals for man's food - both in storage and in the fields - is one part of the cause of famines where these still occur. The Asian landscape is alive with wild pigs, birds of prey, pariah dogs, all in some degree in competition with man.

4. But starvation, both direct and through malnutrition, is part of man's contest with the parsimony of nature rather than of his struggle with animal enemies and competitors. As Malthus saw so clearly, food shortages limit human and all other populations, affecting man differently in hunting, nomadic and agricultural societies. All means of securing food involve an aleatory element, originating in the complex factors which determine the size of animal populations for hunting peoples, and in the weather for agricultural ones. Men have constantly striven to make their cultivation practices proof against the random changes of weather, the outstanding instance being the storing of water for irrigation of rice and other crops, on which about half the world is dependent today. But there was no means by which food supplies could be ensured in each locality. As recently as 1943, Bengal had one of the severest famines of its history which could not be relieved with rice from Burma because of the Japanese occupation of that country. The establishment of wider and wider transport networks has eliminated local famines, an example being the construction of railways in India starting in the 19th century. Today the question raised is the growth of populations of countries and of regions to the point where for economic or political reasons they cannot get sustenance from the surplus areas of the world. Java, with 65,000,000 people, is rapidly outdistancing not only its own food but all the economic and political means by which it might buy or otherwise command food grown elsewhere. The question of a global food shortage will arise at the level of 10 or 12 billions of people if present agricultural techniques do not change radically - it is suggested below that the time of crisis is about 80 years away.

5. Man has appeared as an enemy of man in all ages. Murder and assassination occur everywhere; even in a country where civil order is exemplary like Canada, there were 178 known murders in 1959. The rate in Ceylon is several times this. To the number of murders would presumably be added the number of persons who suffer the death penalty in consequence - the two being in the same class for our purpose if not for the law. In addition motor vehicle accidents are substantial in all civilized countries; Canada had 3,687 in 1959, (4)

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(4) Canada Year Book, page 220 (1961).

or about one for every five thousand population. But the highest murder and accident rates are small compared with the losses of life in war. In World War I the dead are estimated at 9,700,000, in World War II at 54,800,000. (5) Can we say of the deaths in this category, as of those in each of the preceding categories, that there is a long-term decline? We can say no such thing. Quincy Wright counts 278 wars during the period 1480 to 1941 of which about half were in the first period, half in the second. (6) Using statistics for the period 1820-1949, Richardson also finds no trend in the frequency of wars. (7) Since the magnitude of wars has been increasing this makes it probable that deaths also have been increasing; at best they have been constant. What little advance in peacefulness may have occurred has been more than offset by the acceleration in military technology. The calculation of the trend in war-caused mortality will show differences for direct casualties and those due to war-provoked disease - the former at least constant, perhaps increasing, the latter certainly diminishing. Wars are not confined to any one group of countries; the "peace-loving nations" which constitute the membership of the United Nations engage in war as much as any other group. In Wright's count Britain leads with 78 wars, France is next with 71, Spain next with 64. It is plain that the number and bellicosity of the countries near a country will be important factors in its involvement in war, but no rules can be formulated. The only point that is required for the present purpose is that the application of nuclear science to war could offset every benefit of science to health obtained in all previous times.

6. Men also take their own lives. The surprising constancy of suicides from year to year and from one civilized country to another, at a level somewhat under one suicide per ten thousand population, is the gross fact to be observed. The Canadian figures were 1,271 in 1958 and 1,287 in 1959 (8); these are under-estimates in the degree in which survivors of the deceased are able to hide the fact of suicide. But within the relative constancy of the averages are to be found variations of clear social import. Durkheim, (9) writing over half a century ago, showed higher rates for bachelors than for married men, for Protestant countries and regions than for Catholic.

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(5) Petersen, William., Population, The Macmillan Co., New York, page 585 (1961).

(6) Wright, Quincy., A Study of War, University of Chicago Press, Chicago, I, Appendix XX, page 636 (1942).

(7) Richardson, L.F., Statistics of Deadly Quarrels. Quadrangle Books, Chicago (1960).

(8) Canada Year Book (1961).

(9) Durkheim, Emile., Le suicide, Presses Universitaires de France.

7. Aside from attacks on man by himself or by external human, animal, or bacterial enemies, there are the deaths which result from the wearing out of his body. People are saved from bacteria to be carried away by cancer or heart trouble. Because of this the advances of the past few years have very little affected mortality above age 70; projecting trends into the future suggests a pattern whereby we would all live to our seventies and most of us die in that decade, with a few left over to die in their eighties and nineties. The centenarian population can be expected to increase relatively slowly. However, the protection of the body against its own inherent degeneration is becoming the main emphasis of medical research, and this research may be as successful as the attack on disease was in an earlier day. The two major unknowns are starvation, which is likely to increase, and which tends particularly to affect young children, and war which in its most modern form affects all ages equally.

8. The net effect to date of the various kinds of change described above may be measured in various ways, one of which is the comparison of the expectation of life at birth. One supposes that in most parts of the world, in most periods of history prior to about 1800, the expectation at birth was between 25 and 40 years. But with the application of science, particularly to the control of bacteria in any area, a steady increase has appeared. In Canada the first Life Tables, calculated for the deaths of 1930-32, showed an expectation of 60 years for men; that for 1956, two and a half decades later, shows 67.5 years. (10) The improvement, of exactly 3 years per decade, is about what is shown by a UN calculation (11) for the composite of 15 countries between 1900 and 1950, from 49.6 years to 66.0. For women, both in Canada and elsewhere, the decennial increase rose to 4 years in the 1940's and 1950's.

9. These results are nearly universal, with the countries of Asia, Africa and Latin America rapidly catching up to those of the west. Whereas not many years ago the death rates of isolated parts of the world were as high as 30 per thousand, now a list of 25 countries shows for 1959 none outside of the range 7 to 13 per thousand. (12) In many of these countries registration is no doubt incomplete, for places that are backward in sanitation are also likely to be backward in statistics, and one would need to make adjustments for more precise calculation. The United Nations has done this for continents (13) and estimates for Asia a death rate of 33 per thousand in 1950. But its medium projection for the future shows this as falling to 27 for 1960 and to 20 for 1975. Latin America is shown as 12 per thousand in 1975, and though Africa is still high at 29 per thousand it presumably will fall fast thereafter.

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(10) Canada Year Book, page 234 (1961).

(11) Schemas de variation de la mortalité selon l'age et le sexe, Nations Unies, New York, page 27 (1956).

(12) Canada Year Book, page 235 (1961).

(13) Accroissement de la population mondiale dans l'avenir, Nations Unies, New York, page 35 (1958).

10. How is the fall related to wealth or poverty between and within countries? Alfred Sauvy has studied rich and poor districts of Paris, and found that the poor areas had 43 per cent higher mortality than the rich in 1936, but that in 1946 they were only 26 per cent higher. (14) Specific occupations taken at working ages show larger differentials; Petersen cites data from Moriyama and Guralnick which indicates that the age-adjusted mortality of labourers in the United States in 1950 was double that of professionals for men 20-64. Negro mortality in the U.S. at most ages has been about double that of whites. (15) But on the whole social inequality in the face of death, on which many writers have commented, is tending to disappear within countries as well as among countries. Within a country such as France, or a city such as Paris, the convergence of the trends of mortality goes along with a convergence of effective income, including the benefits of Social Security. As between countries per capita income is by no means coming together; the countries of the ECAFE area are growing less rapidly than those of Western Europe. (16) Holland's per capita annual rate or increase of income during the 1950's was about 3.5 per cent against Indonesia's of 1.6 per cent; that of the United Kingdom was about 1.5 per cent against India's 1.1 per cent, and Pakistan's 0.4 per cent, if we compare metropolitan countries and their former colonies. What social security is being transferred among countries in the form of foreign aid and technical assistance, far from equalizing their levels of income does not even equalize their growth rates.

11. The sharpest differentiation must be made, between the application of science to producing wealth in general, and its use towards the lowering of the death rate. The latter seems to depend very little on the former. Whatever the relation may have been in the industrial revolution the underdeveloped countries of today do not need to wait until they are rich and well-educated to cut their death rate. It would be wrong to say that the fall occurs without effort, for both local elites in those countries and the several arms of the United Nations have been energetic agents of change, but as far as the mass of people is concerned the fall in deaths is going ahead with apparent inevitability. To predict a fall in the death rate down to approximately western standards, it is not necessary to assume any other element of development. But it is to be stressed that this fact applies nearly exclusively to deaths from disease; it is only the victory over bacteria that science brings to the underdeveloped world; the trends for starvation and war are another matter.

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(14) Sauvy, Alfred., op. cit., II, page 81.

(15) Petersen, William., op. cit., page 267.

(16) Economic Survey of Asia and the Far East, 1961, United Nations, New York, pages 11 and 12 (1962).

The Trend of Births

12. During most of human history birth rates and death rates have been on the average nearly identical. Suppose that births were exactly 40.0 per thousand throughout history; if deaths were 39.9 per thousand the population would have doubled every 7,000 years, and since just over 30 doublings will bring a single couple to the three billion people who now inhabit the planet, today's world population would issue from a single couple in about 200,000 years, which is considerably less than the time that was available for the purpose. We need not here consider the ups and downs which in fact existed, and which would require modification of the above result. One could find evidence that the virtual identity of birth and death rates is more than a matter of averages, that the historical periods of high births tended to be those of high deaths; births have often risen in wartime, for example. Investigating further, one might well find that a cross-section of the peoples of the world at any given moment would show a tendency for those of high birth rates to be also those of high death rates.

13. If this could be assumed, and something of a leap in logic permitted, one might go on to say that it is the death rate which determines the birth rate. One might cite instances in which parents whose children died "replaced" them; one might use as an argument the trends in Western Europe during the past century, in which the fall in the death rate preceded the fall in the birth rate, figures for which are cited below. This is somewhat the opposite of the Malthusian view that the productivity of the soil controls total population and that it is an excess of births which leads to an excess of deaths. The two points to be made are that the control of births by deaths, actual and prospective, is not inconceivable, and that the condition described below of the large excess of births over deaths is quite exceptional in the world's affairs.

14. It is not clear at what level the down trend in birth rates started. The physiological maximum of human reproduction could only be determined by experiments which are not likely to be carried out. In all societies there is probably some restriction of births - celibacy, delayed marriage, restraint, even primitive forms of contraception. (17) The highest levels of fertility are probably not attained under conditions of promiscuity (18) nor of extreme poverty. Sauvy (19) considers that natural fertility might well be approximated by the figure of 60.1 per thousand which was shown for the Province of Quebec in 1830-40; by 1850-60 the rate had fallen to 45.1, and by 1959 to 28.5. For the United States we are given figures of the average number of children born per woman whose family is completed. (20) The level is 5.0 for the women of child-

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(17) Himes, Norman E., Medical History of Contraception, Baltimore (1936).

(18) Sauvy, Alfred., op. cit., II, page 103.

(19) Ibid., page 110.

(20) Grabill, Wilson H., Kiser, Clyde V., and Whelpton, Pascal K., The Fertility of American Women, John Wiley & Sons, New York (1958).

bearing period around 1870, drops slightly to 4.3 for the period around 1895, then drops very steeply, apparently levelling off in recent times at about 2.5 children. Similar trends appear in most of the countries of Europe, where the decline set in during the 1870's, except for France and Ireland where it began early in the 19th century. (21)

15. Since in all countries deaths fell before births, there was a period in which population increase was very rapid. England and Wales had 9,000,000 people at its first census in 1801 and 36,000,000 at its tenth in 1901. The United States grew from 5,300,000 in 1800 to 76,100,000 in 1900. Some 60,000 French Canadians in 1763 grew to well over 5,000,000 at the present time. The slowest of these - England and Wales - would enable a single couple to people the world to present density in 1500 years. The consequences of so sudden an expansion for the distribution of world population among continents was drastic, as will be shown in Section 3 below. Here we will introduce that subject by contrasting the western countries cited above with India, which in the 1890's was in the normal condition of an underdeveloped country with 45.8 births per thousand and 44.4 deaths. Its deaths fell to 31.2 by the 1930's, while its births remained more or less where they had always been - at 45.2. (22) This separation of the curves of birth and death, the opening of a gap between them, must be what happened at one time in all the presently advanced countries. If India follows their example, with only the difference that deaths fall even more abruptly than they fell in Europe, then it will multiply in an even greater ratio than the western countries did during their period of demographic expansion, i.e. something in the order fivefold.

16. In no western country did the fall of the birth rate take place uniformly for the several statistically recognizable groups. People who were better off, better educated, living in cities, of Protestant religion, in white collar occupations, reduced their families first. Whereas there had been individual variation at all times in family size, it is probable that in most previous and subsequent epochs the difference among social groups was much smaller than it was between say 1900 and 1925. It is likely that the same groups which showed a fall in the death rate were those whose birth rate fell. Statisticians looking at the birth data, without relating them immediately to death figures, in country after country of the western world seemed to see a natural law (i) the birth rate always fell, and (ii) it fell most for the most "advanced" classes. It is only during the last ten or twenty years, with the narrowing and even the reversal of the classical differentials, that the differential birth rate has come to be seen as a purely transitional matter, leading to a new stability in which the various social groups have about the same birth rate. Unfortunately for making the optimistic inference one would like to make about the convergence of the birth rates among countries, the internal convergence has accompanied a convergence of income and radical movement upward in the occupational scale which is not occurring among countries.

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(21) Causes et conséquences de l'évolution démographique, page 81.

(22) Davis, Kingsley, The Population of India and Pakistan, Princeton, page 85 (1951).

17. The principal differential among countries which persists in the west is that between Western Europe, standing well below 20 per thousand, and North America, the USSR, Australia and New Zealand, and the Argentine Republic, which are all between 20 and 30 per thousand. Grouping countries by their birth rates puts Japan with Europe since about 1955. What characterizes the countries of Western Europe and Japan is that they are industrially advanced and short of space. What characterizes the second group - the United States, Canada, the USSR, etc. - is that they are industrially advanced and have a good deal of space. About 500,000,000 people live in countries with a birth rate under 20 per thousand, and an equal number in countries of birth rate between 20 and 30.

18. Continuing with the classification of the countries of the world by their birth rates, we are left with 2,000,000,000 people in countries whose birth rates are over 30 per thousand. These include all of Asia except Japan, all of Latin America except the Argentine and Uruguay, and most of Africa. These countries have barely reached the shoulder of the S-curve of declining births. (23) They do not even, in the cases of Egypt and India for example, show a differential of fertility between city and countryside. Nor, apparently, do their populations respond to small rises in per capita income. Coale and Hoover believe that people reach the "threshhold of decline" when their per capita income rises to about where that of Europe and Japan were at the time when their declines set in; this is probably between five and ten times the per capita income of most of the crowded countries today.

The World's Population Future

19. We now proceed to make use of the data and the argument gathered together above to gain a perspective on the future, treating the world as a unit to begin with, and using United Nations' figures for 1961 which bring its total population to just about 3,000,000,000. The increase at the present time is about 50,000,000 per year or 1 3/4 per cent. (24) If 1 3/4 per cent is somewhat low as an average over the next generation, then 40 years is the longest we would have to wait for a doubling. Just after the turn of the century there will be 6,000,000,000 of mankind, and just after 2040 there will be 12,000,000,000. This is as far as we need carry the projection. We need not go on to the 15 or so doublings that would end with each person having one square foot of the earth's land surface, nor to the 15 or so beyond that which would bring the weight of humans equal to that of the earth itself.

20. Published estimates of the capacity of the earth's surface to provide food and space range from just under the number presently occupying it up to about the 12,000,000,000 we have calculated for 80 years from now. (25) I shall assume that with intensive application of present techniques the twelve billion can

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(23) Coale, A.J. and Hoover, E.M., Population Growth and Economic Development in Low-Income Countries, Princeton, page 16 (1958).

(24) The United Nations shows 1.6 per cent increase for 1960 and 2.0 per cent on the middle projection for 1975.

(25) Causes et conséquences de l'évolution démographique, page 208.

be provided for, and go on to the more interesting matter of how the population would be distributed.

21. Consider the three portions in which the simple classification by birth rates divided the planet, and project these into the future. Assume that the first group, industrialized and densely settled, has a natural increase of about ¼ per cent per year; the second group about 1½ per cent; the third group about 2 per cent. We now apply these rates of increase to the initial figures and see what happens.

	1961		2041	
	Millions	%	Millions	%
I. Largely Europe	500	17	1110	10
II. Largely US and USSR	500	17	1800	15
III. Largely Asia	2000	67	9000	75

The downward shift in the relative population of the first two groups is considerable. It is especially the countries of Europe, the one-time colonial rulers of Asia and Africa, who are now losing their demographic position as well as their political one. Their economic position on the other hand is becoming stronger both absolutely and relatively.

22. But the allocation of world population to the several continents which is thus shaping up is not really new - it is a reversion to an earlier condition. Using Willcox's data for 1800 (26) and confining ourselves to Asia on the one hand and Europe and North America on the other, we find that the population of the former was three times that of the latter in 1800; 2.5 times in 1850; 1.7 times in 1900; about 1.7 in 1950. The ratio is little different on Carr-Saunders' estimates. Continuing these figures with the UN middle projections (27) which are more precise than the rough estimates of the preceding paragraph, we have the following figures:

	Asia	Europe plus North America	Ratio of Asia to Europe + North America
	Millions		
Willcox			
1800	595	199	3.0
1850	656	300	2.2
1900	857	504	1.7
U.N. actual			
1950	1272	760	1.7
U.N. projection			
2000	3870	1259	3.1

(26) Quoted in Causes et conséquences de l'évolution démographique, page 11.

(27) Accroissement de la population mondiale dans l'avenir, page 26.

The ratio of Asia to Europe and North America together is 3.1, which is almost identical with what it was 200 years earlier. The table is eloquent with the story of the demographic expansion of people of European descent, the subsequent stabilization, and the prospective expansion of Asia.

23. The table tells more than that. The expansion of Asia is three-fold during the half century, against less than 70 per cent for Europe in any equal period. This drastic increase in Asia must be put into relation to economic growth, for which we must try to disentangle two quite opposite views of the relation of population to development.

Population, Economic Growth, and War

24. The first is that of Adam Smith, Durkheim, and Colin Clark. Smith believed that the division of labour was responsible for, and indeed virtually constituted, development, and in a famous proposition he related the division of labour to the size of the market. The relation of the size of the market to population volume and density is a complicated matter and this is not the place to study it. Durkheim (De la Division du Travail Social, PUF, 1960) came at the problem in different fashion, arguing that the pressure of population in a limited space, if people are effectively in human or moral contact with one another, forces the individual members to differentiate themselves. As did Darwin in relation to the animal world, Durkheim believed that competition is most intense between like individuals or species, and the way for an individual to moderate the intensity of competition which he faces is to differentiate himself, to find a niche. The result of moral pressures and incentives where the volume and density of society are great is not only the economic division of labour, but the whole process by which individual personalities are intensified, professional and other associations multiply and individual ambition expands without limit. To these arguments of a sociological character may be added the economic case made, for example, by Colin Clark. (28).

25. What is to this school a cause, or at least a partial stimulus, of the industrial revolution, is looked on by others, in application to present-day Asia, as the chief block to development. As a result of the extraneous discoveries of western science, neither cause nor result of Asia's industrialization, the death rate is declining rapidly. The 1961 ECAFE report, commenting on the fact that recent censuses have revealed considerably more population than had been anticipated, explains that plans have "to be revised to take account of the needs created by bigger annual increase of population in regard to imports, transport requirement, power supplies, schools and other social expenditures." (29) India's annual growth rate, for example, is not 1.3 per cent per year as had been thought, but 2.0 per cent. The per capita nutritional levels for ECAFE countries, which "had already appeared distressingly low," are now seen to have been over-estimates. A more sophisticated argument is that of the need for capital. If it takes 3 dollars to equip a person so that he can earn 1 dollar of income per year, then the equipping of 2.3

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(28) Coale, A.J. and Hoover, E.M., op. cit., page 240.

(29) Economic Survey of Asia and the Far East, page 119 (1961).

per cent of additional population each year will require 7 per cent of income. This is approximately the average rate of saving in the area, with some countries higher, others lower. Even India by dint of enormous effort has succeeded in raising its rate of saving up to only about 8 per cent. (30) Insofar as the rate of domestic saving is the limiting factor in investment, the equipping of new population at the pre-existing level of technology competes with the new investment that will raise per capita income. A thorough evaluation of this aspect of economic growth is provided by Coale and Hoover.

26. When one further takes account of the diminishing returns to land, which a crowded country will have to face in securing its food and the raw materials for its manufactures, the problem is intensified one further stage. Diminishing returns apply in the securing of each additional ton of rice, whether that rice is raised on newly broken land or is additional yield on land already under cultivation. However, a modifying factor of unknown strength is the use of new agricultural techniques, which can in a certain range at least, though hardly indefinitely, counter the parsimony of nature.

27. We thus have on the one hand the view that dense population generates that division of labour which is associated with the introduction of science into production and so with the industrial revolution, and the opposite view that growing population will sink the whole process. I believe that both are true in different circumstances, and that at a certain density of population in relation to resources comes the point of transition at which population density begins to work against development. However difficult it may be to specify that point exactly, there is no doubt that India and Java have passed it.

28. In any underdeveloped crowded country with a liberal political framework, which sets the raising of per capita income as its primary objective, we can speak of a race between population growth and development. If by the considerable effort which is being made, for example in India, income can for a sufficient period of time rise faster than does population, then the various social consequences of that rise of income will make themselves felt: education, the growth of cities, communication through newspapers and radio, etc. Large numbers of peasants will become urban dwellers with urban jobs and ambitions, and the direct consequences for family limitation which these have everywhere implied. Once there are enough of such new kinds of people, there will not be any further population problem. Responsive as they will be to signals of all kinds, from the suggestions of their friends to those of the price system, they will come to have about the number of children that the economic position of the country requires. One will then be able to say that economic development has won the race with population. The reverse situation, in which population growth keeps up with the growth of income so that per capita income barely rises and such saving as occurs is taken up with providing necessary equipment for each year's increment of population, is equally easy to visualize. Here one can say that the race for economic development is being lost, and the positive checks to population of which Malthus warned will come into effect.

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(30) India 1961, Publications Division, Government of India, page 176.

29. But if there is a race of this kind, whose result is so crucial, can one not take the obvious short-cut? Why wait for development to control population through education, changed jobs, the attitudes of urban dwellers? Since only a psychological barrier is involved, people ought to be persuaded directly to use birth control. Calculations have been made showing that paying men to let themselves be sterilized, or couples to control their reproduction, is a more productive investment than steel mills. This policy has in some degree been put into effect in India, but the very slow spread of the new practices shows that the psychological can offer as solid a barrier as the physical.

30. The resistance is particularly solid when the pressure to use birth control comes from outside. Westerners can counsel Asians on the most rational economic grounds, but the advice is received as a kind of obscenity. Very close to the surface of consciousness among nearly all peoples, and proof against most rational argument, is the thought that population is in a mysterious sense a strength and not a weakness. It is fortunate indeed that western governments have restrained their impulses to exercise pressure, for instance by tieing foreign aid to population control; such pressure could only have the effect of strengthening Asians in their suspicion that a power-play was involved and that the west was trying by sophisticated argument to overcome its demographic weakness.

31. Underdeveloped societies are less individualistic than those of Western Europe and America, and they are accordingly less inclined to give up having large numbers of children on the ground that fewer could be looked after better. Aside from possible historic and philosophical reasons which underlie this, there are two reasons of the most grimly practical nature, both of which become congenial in proportion as an authoritarian system is in prospect to frame the development process. In most underdeveloped countries a degree of centralized authority is less repugnant than it is for the majority of people in Western Europe and America.

32. The first of the reasons that would change the relation of population and development from the liberal model referred to above is the ability of the central authority, by threat, ideology, and material inducement, to make people work longer and harder than they would work for wages alone. A country's power-investment optimum population is very much larger if the average working day is twelve hours than if it is six hours. The longer a farmer can get his horse to work the more worthwhile it is to keep it. When the ruler can regard his population as horses he will want to have more of them than if he has to treat them as the difficult and sensitive creatures that men are.

33. The second reason is the danger of war. If a modern war breaks out losses may be very great. Current books on strategy talk cheerfully about death rates of 50 per cent and more in a war lasting a few hours. In the face of such losses, would not one be wise to stock-pile people? Like any other stock, people cost money, but if they are peasants they do not cost as much as urban dwellers, and they are especially cheap if they can be made to work twelve hours a day. If war comes to the country in question, the loss of

50 per cent will bring populations down to what the economic calculations say it ought to have been all along. If it comes to a neighbouring country, then the superfluous 50 per cent can move across the boundary when the radioactivity has died down. If war clears a distant continent, there will be a race to transport the people who will appropriate it. Without having any concrete evidence of the extent to which this notion is disseminated, of how far it reaches down from the elite to the masses, one cannot but note that mainland China appeared to be veering towards a policy of birth control and then changed to encouraging population just at the time when missile-born thermonuclear war became technically feasible.

34. Our age is teaching itself to face the grimmest of possibilities, to think the unthinkable. There is only one further stage beyond growing population in a kind of seed-bed to take up space that may later be cleared by nuclear weapons. That is the deliberate use of such weapons to make space for surplus population, a use which may yet be added to the repertoire of international politics.

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